SECTION 23 09 10
CENTRAL PLANT OPTIMIZATION (CPO) SYSTEM

PART 1 – GENERAL

1.1 DESCTIPTION

A. This Section includes a relational optimization control system for chilled water plants, including optimization software and controller as part of the Base Bid. Under Deduct Alternate 1, delete the Central Plant Optimization System from the project.

B. The section 23 09 23 Direct-Digital Control System for HVAC provides connection for all the control points of the various equipment and systems along with graphics based operator interface systems and equipment and basic sequence and control functions for all systems and components.

C. The Central Plant Optimization (CPO) system provides information to provide optimized control parameters of the HVAC plant in the facility to the DDC system. The CPO software provider is responsible for achieving, verifying and maintaining stated performance of the HVAC plant and for the building as a whole as specified in this section.

D. The Section 23 09 23 Direct-Digital Control System for HVAC subcontractor is responsible for installing and connecting all the Section 230910 hardware that is supplied, then programmed and fine-tuned by the Central Plant Optimization System software provider in accordance with the requirements of this Section.

1.2 RELATED WORK

A. Section 23 08 00, Commissioning of HVAC Systems.

B. Section 23 21 13, Hydronic Piping.

C. Section 23 21 23, Hydronic Pumps.

D. Section 23 64 00, Packaged Water Chillers.

E. Section 23 65 00, Cooling Towers.

F. Section 26 05 11, Requirements for Electrical Installations.

G. Section 26 05 21, Low-Voltage Electrical Power Conductors and Cables (600 Volts and Below).

H. Section 26 05 26, Grounding and Bonding for Electrical Systems.

I. Section 26 05 33, Raceway and Boxes for Electrical Systems.

J. Section 26 27 26, Wiring Devices.

K. Section 26 29 11, Motor Starters.

1.3 DEFINITIONS

A. BACnet: An entirely non-proprietary and open control network platform for designing and implementing interoperable control devices and networks.

B. DDC: Direct digital control.

C. Relational Control: A method of optimizing all-variable speed systems based on the Equal Marginal Performance Principle. The optimization requires dynamic set point control adjusting every chilled water system component simultaneously every 30 seconds based on chilled water system load requirements. The optimization requires the valve orifice method with flow-based control. This excludes Proportional, Integral, Derivative (PID) control loop or fixed set point control.

D. Central Plant Optimization (CPO) Software provider: CPO software provider to control contractor that provides relational control optimization HVAC controller and software compatible with and integrated into the DDC control system energy performance of the facility.

E. I/O: Input/output.

F. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

G. MS/TP: Master slave/token passing.

H. PC: Personal computer.

I. PID: Proportional plus integral plus derivative.

J. RTD: Resistance temperature detector.

1.4 QUALITY ASSURANCE

A. Criteria:

1. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegates the responsibility to a single source controls installation subcontractor. The controls subcontractor shall be responsible for the complete design, installation, and commissioning of the system. The controls subcontractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity.

2. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer’s latest standard design and have been tested and proven in actual use.

3. The controls subcontractor shall provide a list of no less than ten similar projects which have building control systems as specified in this Section. These projects must be on-line and functional such that the Department of Veterans Affairs (VA) representative would observe the control systems in full operation.
4. The controls subcontractor shall have in-place facility within 50 miles with technical staff, spare parts inventory for the next five (5) years, and necessary test and diagnostic equipment to support the control systems.
5. The controls subcontractor shall have minimum of three years experience in design and installation of building automation systems similar in performance to those specified in this Section. Provide evidence of experience by submitting resumes of the project manager, the local branch manager, project engineer, the application engineering staff, and the electronic technicians who would be involved with the supervision, the engineering, and the installation of the control systems. Training and experience of these personnel shall not be less than three years. Failure to disclose this information will be a ground for disqualification of the supplier.
6. Provide a competent and experienced Project Manager employed by the Controls Contractor. The Project Manager shall be supported as necessary by other Contractor employees in order to provide professional engineering, technical and management service for the work. The Project Manager shall attend scheduled Project Meetings as required and shall be empowered to make technical, scheduling and related decisions on behalf of the Controls Contractor.

B. Codes and Standards:
1. All work shall conform to the applicable Codes and Standards.
2. Electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled

1.5 PERFORMANCE

A. Central Plant Optimization: Energy Performance Requirements
1. Central Plant Optimization Hardware and software optimization provider shall provide a one (1) year equipment warranty.
2. Central Plant Optimization Hardware and software must be capable of LonWorks, ModBus and BACnet integration with multiple Building Automation System (BAS) providers.

3. Optimization shall be based on standard, packaged software that includes sequences proven through at least 5 building site references.
4. Optimization provider will provide measurement, verification and management of central chilled water plant optimization. CPO software provider will work with BAS provider to make it possible to gather, store and share HVAC system operating data in a format that is easy to access, use, analyze and share via the Web.

1.6 WARRANTY

A. Provide as a part of this contract a full one (1) year parts, service and labor warranty for CPO controller(s) supplied and installed under this agreement. Such warranty period begins at system acceptance.
B. Provide a full 1 year service and labor warranty for all firmware and software provided in the execution of this scope of work. During the warranty period all manufacturer’s regular system software and firmware upgrades shall be provided as part of this extended warranty.
C. During warranty period, all calls for warranty assistance shall be returned with fifteen (15) hours.

1.7 SUBMITTALS

A. High Level Network Topology Schematic: Coordinate to support Section 23 09 23 Direct-Digital Control System for HVAC subcontractor to develop a schematic, not for construction, HVAC control network connection schematic that shows Optimization appliance’s and BAS’s intended network connection.
B. Product Data: Include manufacturer’s technical literature for each control device. Indicate dimensions, capacities, performance characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. CPO system hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for interface equipment, optimization control units.
C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Bill of materials of equipment indicating quantity, manufacturer, and model number.

D. Data Communications Protocol Certificates: Certify that each proposed DDC system control component complies with ASHRAE 135 incorporating BACnet communication protocol.

E. Qualification Data: Provide verification showing that the CPO software provider is licensed and authorized to apply the technologies for this system application.

E. Overall Performance Assurance Requirements – Optimization provider will provide a Web-based performance measurement, verification and management service that delivers continuous verification of performance and savings for a period of one (1) year. The service shall include ongoing HVAC system energy reduction verification by providing detailed real-time and historical performance data and analysis capabilities that enable HVAC system operators to quickly detect, diagnose and repair system faults and prevent performance degradation.

F. Central Plant Optimization System shall be installed and configured to provide a secure persistent internet connection using the VPN capabilities of the building's firewall and network management facilities to achieve the remote monitoring requirement or as otherwise directed by the COTR.

G. CPO subcontractor shall provide data and information to ensure system energy performance requirements of this specification are achieved, verified and maintained over time.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Central Plant Optimization control system installer must be an authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices and Accessories: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.9 DELIVERY, STORAGE AND HANDLING

A. Field-Mounted Components: Where control devices specified in this Section are indicated to be field mounted on equipment, arrange for shipping of control devices to location.

B. System Software: Latest software version provided.

1.10 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):

Standard 135-10.....BACNET Building Automation and Control Networks

C. American Society of Mechanical Engineers (ASME):

B16.18-01.....Cast Copper Alloy Solder Joint Pressure Fittings.
B16.22-01.....Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. American Society of Testing Materials (ASTM):

B32-08.....Standard Specification for Solder Metal
B88-09.....Standard Specifications for Seamless Copper Water Tube
B88M-09.....Standard Specification for Seamless Copper Water Tube (Metric)
B280-08.....Standard Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service
D2737-03.....Standard Specification for Polyethylene (PE) Plastic Tubing

E. Federal Communication Commission (FCC):

Rules and Regulations Title 47 Chapter 1-2001 Part 15: Radio Frequency Devices.

F. Institute of Electrical and Electronic Engineers (IEEE):

802.3-11.....Information Technology-Telecommunications and Information Exchange between Systems-Local and Metropolitan Area Networks- Specific Requirements-Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access method and Physical Layer Specifications

G. National Fire Protection Association (NFPA):

70-11.....National Electric Code
90A-09.....Standard for Installation of Air-Conditioning and Ventilation Systems

H. Underwriter Laboratories Inc (UL):

94-10.....Tests for Flammability of Plastic Materials for Parts and Devices and Appliances
294-10.....Access Control System Units
486A/486B-10.....Wire Connectors
555S-11.....Standard for Smoke Dampers
916-10.....Energy Management Equipment
1076-10.....Proprietary Burglar Alarm Units and Systems

1.11 OPTIMIZATION SEQUENCES

A. Provide, install, adjust, and tune all CPO sequences directly or indirectly required for proper functioning and performance of the optimization.

B. Coordinate CPO software to interface with DDC Controls that are supplied and installed by the Section 23 09 23 Direct-Digital Control System for HVAC subcontractor.

C. CPO software vendor shall provide proof of software performance with efficiency data spanning a minimum of 1 year for at least 5 sites.

PART 2 - PRODUCTS

2.1 CENTRAL PLANT OPTIMIZATION SYSTEM

A. Central Plant Optimization System shall consist entirely of electronic digital controllers from one or more of the above, configured as approved, fully compatible with the network standards of this specification and with the equipment supplied for the section 23 09 23 Direct-Digital Control System for HVAC.

B. Central Plant Optimization System shall include the following:

1. All required hardware/software to meet the requirements of the drawings and these specifications.
2. Web-based troubleshooting and reporting functionality and service so that performance is verified and reported quarterly and performance faults are annunciated and promptly corrected during the warranty period.
3. Any optimization system that does not provide ongoing measurement and verification of optimized performance shall not be acceptable.
4. Optimization algorithms shall instruct the BAS for optimization without the use of PID loops or hunting.

C. Central Plant Optimization controller: Modular, comprising processor board with programmable, random-access memory and local operator access.

1. Controller monitors and processes information for optimized control and provides information and optimized settings to the DDC system that executes commands.
2. Optimization controller resides on the main BACnet network with DDC system panels.

D. Dual mode operation capability

1. Optimization software shall exist exclusive of the BAS and have the ability to operate in two modes: standard BAS (automation) mode and optimized mode.
2. The software shall include a provision for transitioning from one mode to the other while the plant is operating.

E. Remote monitoring, fault detection, performance verification and report generation.
1. Central Plant Optimization System shall be installed and configured to provide a secure persistent internet connection using the VPN capabilities of the building’s firewall and network management facilities to achieve the remote monitoring requirement.
2. Plant system and equipment trend data shall be captured at 5 minute intervals and stored remotely on a secured server for a minimum of 1 year. Data shall be accessible via a standard web browser.
3. Provide plant efficiency reports that summarize performance, provide graphical representation of key operating statistics and include a summary of any plant issues that are negatively impacting efficiency and need to be resolved.
4. System shall include graphical displays of plant operating data for a period of 1 year to assist in fault diagnosis and resolution which shall be accessible via a standard web browser.

F. Performance Verification and Report Generation
1. Web-based software shall provide metrics comparing standard BAS and optimized mode indicating, but not limited to: KWH savings, CO2 savings, and Dollar savings
2. Web-based software shall continuously display a trend graph showing the simulated efficiency of the standard BAS mode and the current, actual, measured efficiency in kw/ton.
3. System shall include graphical displays of plant operating data for a period of 1 year to assist infault diagnosis and resolution which shall be accessible via a standard web browser.

G. **OPTIMIZATION ALGORITHMS**
1. CPO shall utilize software and programming algorithms that are based on the Relational Control, Valve Orifice Methodology, and Equal Marginal Performance Principle (EMPP) of system optimization through Demand Based Control techniques. The CPO shall variably control quantity of equipment run, motor speed, and chilled water

output temperature according to the EMPP. The CPO shall do the following:

a) Receive data about the system performance and loads from the BMS.

b) Calculate chilled water pump speed using the valve orifice method and integrate chilled water temperature set point control to pump control for optimal system performance.

c) Use the natural efficiency curve of the chillers to determine, based on load and leaving condenser water temperature, the optimal number of chillers to run.

d) Utilize the EMPP and power relationships between the cooling towers, condenser pumps, and chillers to determine the optimal number of pumps and towers to run, as well as what speed to run the motors.

e) Compute and return to the BMS system new equipment speeds and set points every 30 seconds, and shall change values less than 2 percent of full range per 30-second monitoring cycle

2.2 CPO Savings Analysis

A. An analysis report showing expected savings with CPO shall be presented with the CPO submittal package. Submittals not accompanied by this analysis will be rejected

1. The analysis shall establish a Base Energy Efficiency (KW/ton) of the entire chiller plant using the plant configuration in the plans and specifications provided by the design engineer.
2. The analysis shall provide efficiency gain statistics showing Energy Savings (kWh/year), Demand Energy Reduction (KW), Cooling Tower Water Savings (Gallons / year), and CO_2 Emissions Reduction (Pounds / year).

2.3 CPO / BAS measurement and integration points required.

A. BAS supplier shall provide measurement points including but not limited to the below points as required for use by the optimization system through the BAS ↔ CPO BACnet connection.

1. Measurement for all motor kWs, including pumps, towers, and chillers: The kW is a measured by direct instrumentation and is not a calculated value. The kW measurement must meet the spec below. The Veris 8000 series power meter is an example of an acceptable power meter. If the VFD complies with the capability listed below, a meter is not required.

a) The power meter shall consist of three CTs.
b) The meter shall measure true (rms) power, instantaneous demand kW.
c) The meter shall be calibrated as a system and be accurate to +/- 1% from 7 % to 100 % of the rated current over a temperature range of 0-60° C.
d) The meter shall conform to ANSI C12.1 metering standards.

2. Flow Measurement: If there is a bypass or decoupler, the supply and return temperature sensors along with flow meter will need to be installed on the chiller side of the piping. The flow meter needs to be installed such that total flow through the chiller evaporator is read at all times, even if the bypass valve is open.
3. VFD Speed feedback and setpoints: All speed setpoints for VFDs are provided as a percentage and are based on an absolute percentage of 60Hz, ie 50% = 30Hz, 75%=45Hz, 100% =60HZ. The feedbacks from the drives are also transmitted as a percentage with the same requirements, based on an absolute percentage of 60Hz.
4. Every Pump/Fan VFD shall provide the following points:

Device	Point Description	Point Label	Unit
Fan or Pump #X	Motor kW	CT1kW	kW
	VFD Speed Setting	CT1RPM	0-100%
	VFD Status	CT1S	Running/Off
	VFD Failed (BAS Alarm)	CT1Failed	Alarm/Normal
	VFD Start/Stop Command	CT1SS	Enable/Disable

5. Chiller Points - Every chiller shall provide the following points:

Device	Point Description	Point Label	Unit
Chiller Points	Chilled Water Supply Temperature	CH1CHWST	°F
	Chilled Water Return Temperature	CH1CHWRT	°F
	Condenser Supply Water Temperature	CH1CDWST	°F
	Condenser Return Water Temperature	CH1CDWRT	°F
	Condenser Refrigerant Temperature	CH1CDT	°F
	Evaporator Refrigerant Temperature	CH1EVT	°F
	Condenser Refrigerant Pressure	CH1CDP	PSI
	Evaporator Refrigerant Pressure	CH1EVP	PSI
	Chiller Alarm/Fault Msg	CH1F	Alarm/Normal
	Total Chiller kW	CH1kW	kW
	Chiller Demand Limiting	CH1DMD	%FLA
	Chiller State	CH1S	Message or Status
	Chilled Water Supply Temperature Setpoint	CH1CHWSTSP	°F
	Chiller Start/Stop	CH1SS	Enable/Disable
	Chiller Failed (BAS Alarm)	CH1ALARM	Alarm/Normal
	Chiller CHW Valve Command	CH1CHWVLV	Open/Close
	Chiller CDW Valve Command	CH1CDWVLV	Open/Close
	Compressor 1 State	CH1COM1S	Message
	Compressor 1 Motor RPM / VFD Speed	CH1COM1RPM	%
	Compressor 1 General Fault	CH1COM1F	Alarm/Normal
	Compressor 1 IGV position / Vane Position	CH1COM1IGV	0-100%
	Compressor 1 kW	CH1COM1kW	kW
	Compressor 2 State	CH1COM2S	Message
	Compressor 2 Motor RPM	CH1COM2RPM	%
	Compressor 2 General Fault	CH1COM2F	Alarm/Normal
	Compressor 2 IGV position	CH1COM2IGV	0-100%
	Compressor 2 kW	CH1COM2kW	kW
	Compressor 3 State	CH1COM3S	Message
	Compressor 3 Motor RPM	CH1COM3RPM	%
	Compressor 3 General Fault	CH1COM3F	Alarm/Normal
	Compressor 3 IGV position	CH1COM3IGV	0-100%
	Compressor 3 kW	CH1COM3kW	kW
	Compressor 4 State	CH1COM4S	Message
	Compressor 4 Motor RPM	CH1COM4RPM	%
	Compressor 4 General Fault	CH1COM4F	Alarm/Normal
	Compressor 4 IGV position	CH1COM4IGV	0-100%
	Compressor 4 kW	CH1COM4kW	kW

6. System Points – The BAS shall provide the following points:

Device	Point Description	Point Label	Unit
Sensor - temp	Outside Air Temperature	OAT	°F
Sensor - hum	Outside Air Humidity	OAH	0-100%
Sensor - pres	CHW Differential Pressure	CHWDP	DPSI
Sensor - temp	Return Temperature (to CT)	CDWRT	°F
Sensor - temp	Supply Temperature (from CT)	CDWST	°F
Sensor - temp	Chilled Water Return Temperature Before Bypass	CHWRTB	°F
Sensor - temp	Chilled Water Supply Temperature Before Bypass	CHWSTB	°F
Sensor - temp	Chilled Water Return Temperature	CHWRT	°F
Sensor - temp	Chilled Water Supply Temperature	CHWST	°F
Sensor - flow	Chilled Water Flow	CHWFLO	GPM
Bypass Valve	CHW Low Flow Bypass Valve Position	CHWBPV	0%-100%
Bypass Valve	CDW Low Temperature Bypass Valve Position	CDWBPV	0%-100%
Sensor - temp	Heat Exchanger CHW Supply Temperature	HXxCHWST	°F
Sensor - temp	Heat Exchanger CHW Return Temperature	HXxCHWRT	°F
Sensor - temp	Heat Exchanger CDW Supply Temperature	HXxCDWST	°F
Sensor - temp	Heat Exchanger CDW Return Temperature	HXxCDWRT	°F
Isolation Valve	Heat Exchanger CHW Isolation Valve	HXCHWVLV	0-100%
Isolation Valve	Heat Exchanger CDW Isolation Valve	HXCDWVLV	0-100%

7. Valve Positions: The BAS shall transmit valve positions back to the CPO software:

Device	Point Description	Point Label	Unit
CHW Cooling Coils(AHU's, FCU's, DP's, etc..)	Chilled Water Valve Position #1/ DP#1	CHWV1	0-100% or PSIG
	Chilled Water Valve Position #2 /DP#2	CHWV2	0-100% or PSIG
	Chilled Water Valve Position #3 /DP#3	CHWV3	0-100% or PSIG
	Chilled Water Valve Position #4 /DP#4	CHWV4	0-100% or PSIG
	Chilled Water Valve Position #5	CHWV5	0-100%
	Chilled Water Valve Position #6	CHWV6	0-100%
	Chilled Water Valve Position #7	CHWV7	0-100%
	Chilled Water Valve Position #8	CHWV8	0-100%
	Chilled Water Valve Position #9	CHWV9	0-100%
	Chilled Water Valve Position #XX	CHWV10	0-100%

B. BAS Integration Points: BAS supplier shall provide integration points including but not limited to the below points through the BAS ↔ CPO BACnet connection.

1. BAS Status Points: (mode points that are controlled by programming)

Device	Point Description	Point Label	Unit
BAS Determined points	Chiller System Enable Point	CLGREQD	on/off
	Chiller System Under BAS Control	BASMODE	on/off
	Chiller System Under CPO Control	CPOMODE	on/off
	Comunications with CPO Controller Lost	COMSLOSS	Normal/Alarm
	Communications Loop	BASWATCHDOG	Value
	Free cooling mode point	CLGMODE	value

2. CPO Calculated Points: (Read from CPO software and executed by the BAS)

Device	Point Description	Point Label	Unit
CPO to BAS Instruction Points	Calculated Chilled Water Pump Speed	CHWPRPM	0-100%
	Calculated Condenser Water Pump Speed	CDWPRPM	0-100%
	Calculated Cooling Tower Fan Speed	CTFRPM	0-100%
	Calculated Chilled Water Temperature Setpoint	CHWSTSP	40-58°F
	Calculated Chiller Amp Demand Limit Setpoint	CHDMD	40-100%
	Number of Chillers to run	CHLRTR	0-n *
	Number of Chilled Water Pumps to run	CHWPTR	0-n *
	Number of Condenser Water Pumps to run	CDWPTR	0-n *
	Number of Cooling Towers to run	CTTR	0-n *
	Condenser Water Bypass Valve Control Command	CDWBPVLV	0-100%
	OLC changes value when this value matches BASWATCHDOG	CPOWATCHDOG	0-100
	CPO Controller Ready	CPOCREADY	Off/Ready
	Enable Cooling Tower Fan	RUNCTFAN	On/Off
	Enable Low Load Function of Chiller Plant	LOWLOAD	On/Off
	Free Cooling Mode Enable	FREECLGALERT	On/Off

* n = Number of that item of equipment at this plant

1.10 CENTRAL PLANT OPTIMIZATION – POINTS DEFINITIONS AND EXPLANATIONS

A. See below for clarification on points called out in the Integration and BAS sections.

B. CLGREQD (BAS to CPO): In CPO operation the chiller plant is based on call for cooling from the system served. CLGREQD is set to true by the BAS to communicate to the CPO Controller that cooling is required.

C. COMSLOSS (BAS to CPO): The BAS point COMSLOSS is set to true if the BAS determines there is a communications failure.

D. CPOMODE (BAS to CPO): The BAS point CPOMODE is set to true when desired plant mode is to follow CPO direction. CPOMODE should remain active as long as COMSLOSS is false and the plant is ready to accept CPO set points. The BAS should *not* interlock CPOMODE to CLGREQD or CPOCREADY.

E. BASMODE (BAS to CPO): The BASMODE point is set to true when the BAS is not following CPO direction. This point is *not* interlocked with CPOMODE. This point is not used by the CPO, it is only for verification of current BAS operating mode.

F. CPOWATCHDOGBAS (BAS to CPO): The BAS writes the value from CPOWATCHDOG to this point. The CPO will monitor this point. When CPOWATCHDOG and CPOWATCHDOGBAS match it will change the value of CPOWATCHDOG. If the signal fails to change state for more that 60 seconds, communications is deemed lost.

G. CPOWATCHDOG (CPO to BAS): Both the BAS and CPO will monitor communications with each other via the CPOWATCHDOG and CPOWATCHDOGBAS point. The OLEC will write a value to the CPOWATCHDOG point, the BAS will then write that value to the CPOWATCHDOGBAS point. The BAS will monitor this point. If the signal fails to change state for more that 60 seconds, communications is deemed lost.

H. CPOCREADY (CPO to BAS): When CPOCREADY is “true,” the BAS can safely follow the CPO integration point values. When CPOCREADY is “false,” the BAS follows its original sequences.

I. BPVLV (CPO to BAS): This point is the percent open by which the bypass valve shall be opened. After CHWP startup, this point is used to control CHW minimum flow. The BAS will follow all the values listed below if CPOCREADY and CPOMODE are true and BASMODE is false.

J. CHWPRPM (CPO to BAS): Pump speeds are controlled by the BAS according to the CPO supplied value CHWPRPM . When two or more pumps are operating, all CHW pumps operate at identical speed according to the CHWPRPM point.

K. CDWPRPM (CPO to BAS): Pump speeds are controlled by the BAS according to the CPO supplied value CDWPRPM. When two or more pumps are operating, all CDW pumps operate at identical speed according to the CDWPRPM point.

L. CTFRPM (CPO to BAS): Cooling tower fan speeds are controlled by the BAS according to the CPO supplied value CTFRPM when RUNCTFAN is active. When two or more tower fans are operating, all tower fans operate at identical speed according to the CTFRPM point.

M. CHWSTSP (CPO to BAS): The BAS receives and uses the chilled water temperature set point (CHWSTSP) supplied by the CPO when operating under CPOMODE. All operating chillers use the same CHW set point.

N. CHDMD (CPO to BAS): The BAS receives and uses the Chiller Demand Limit (CHDMD), which determines the chiller's %RLA (Running Load Amperage) limit, for each running chiller.

O. CHLRTR (CPO to BAS): The CHLRTR signal originates from CPO and is an analog 0-N (N = number of chillers at this plant) signal sent to the BAS. The signal's value will increase (or decrease) when the CPO wants the BAS to add or subtract a lag chiller.

P. When CHLRTR is increased from 0 to 1, the "Start-up of Lead Equipment" sequence is executed. When CHLRTR is 1 and increased to 2 (or more), the "Start-up of Lag Equipment (section 2.1)" sequence is executed. Similarly, when CHLRTR is decreased to 1 or 0, the sequences "Shutdown of Lag Equipment (section 2.2)" or "Shutdown of Lead Equipment and CHW System (section 2.3)" are executed as appropriate.

Q. CHWPTR (CPO to BAS): This point indicates the number of chilled water pumps to run. Typically, the chilled water pumps operate one pump with one chiller. If CPO determines it is more efficient to run two or more pumps with the operating chiller(s), it will increase the CHWPTR signal. This signal informs the BAS when to add or remove a pump. This may happen concurrently with a CHLRTR signal.

R. CDWPTR (CPO to BAS): This point indicates the number of condenser water pumps to run. Typically, one condenser pump operates with each chiller. If CPO determines it is more efficient to run two or more pumps with the operating chiller(s), it will increase the CDWPTR signal. This signal informs the BAS when to add or remove a pump. This may happen concurrently with a CHLRTR signal.

S. CTTR (CPO to BAS): This point indicates the number of cooling towers to run. If CPO determines it is more efficient to run two or more cooling towers with the operating chiller(s), it will increase the CTTR signal. This signal informs the BAS when to add or remove a tower. This may happen concurrently with a CHLRTR signal. Note that this point only indicates when to allow condenser water flow into the tower; the cooling tower fans remain off unless RUNCTFAN is on (see RUNCTFAN point below)

T. RUNCTFAN (CPO to BAS): When this point is active, the BAS will turn on the fans in each running cooling tower and run the fans at the speed indicated by the CTFRPM point.

U. FREECLGALERT (CPO to BAS): In CPO 30 operation, the plate and frame water-side economizer is operated (with no chillers) when outside wet bulb conditions allow. The CPO evaluates the current weather and load conditions to determine whether it is suitable to use free cooling mode. FREECLGALERT is set to true by the CPO to communicate to the BAS to activate the plate-and-frame heat exchanger operation. The BAS may choose to follow this point or may choose to enable or disable free cooling mode based on its own criteria. The BAS is responsible for transitioning the chiller plant from mechanical cooling to free cooling mode and back again. The CPO does not rely on this point to determine if the plant is operating in free cooling mode or not (see CLGMODE point and below).

V. CLGMODE (BAS to CPO): This point is used by the BAS to communicate to the CPO that the system is in mechanical cooling mode (chillers only), free cooling mode, or transitioning from one mode to another. The CPO will calculate set points differently depending on whether the system is in mechanical cooling or free cooling mode. This point will be an analog point with values 0, 1, 2, and 3 as indicated below:

1. 0 – Mechanical cooling mode. The chillers are enabled and provide 100% of the cooling for the plant.
2. 1 – Transitioning from mechanical cooling to free cooling mode. During this mode the BAS will temporarily stop following CPO set points and will control the appropriate equipment (pumps, chillers, cooling towers, and valves) to change over the plant from mechanical cooling mode to free cooling mode. All timers and set points are handled by the BAS during this transition.
3. 2 – Free cooling mode. The chillers are disabled and the free cooling heat exchanger(s) provide 100% of the cooling. The CPO will send the appropriate set points for the running pumps and cooling towers to optimize the plant in this mode.
4. 3 – Transitioning from free cooling mode to mechanical cooling. During this mode the BAS will temporarily stop following CPO set points and will control the appropriate equipment to change over the plant from free cooling mode to mechanical cooling mode. All timers and set points are handled by the BAS during this transition.

W. LOWLOAD (CPO to BAS): At very low loads, the operation of the lead (only operating) chiller is disabled to provide chilled water more efficiently. When LOWLOAD is active, the BAS 'stops' the operating chiller, while leaving isolation valves open because the pumps continue to run. At 'low load' there should have been only one chiller operating. After 1 minute the chiller is shutdown, the running CDWP(s) and CTFAN(s) are stopped. The CHWP remains running. The LOWLOAD directive will be on for a minimum time of 10 minutes (adjustable at CPO).

1. When the LOWLOAD directive is removed by CPO, the lead condenser pump is enabled and follows CDWPRPM. One minute after the CDWP run status is received by the BAS, the BAS enables the lead chiller. Once the lead chiller has started, the condenser pump speed and tower fans are again controlled by their CPO originated points. At this point the system has returned to normal operation.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Supply all required equipment to Section 23 09 23 DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC subcontractor along with instructions and support for that subcontractor to install, connect and power all equipment required in this Section.

B. Install software in controller supplied by this Section. Implement all features of programs to specified requirements and as appropriate to sequence of operation.

C. Configure software to achieve system optimization and energy performance specified.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After the BAS is commissioned, CPO software provider shall complete functional testing.
2. Test each system for compliance with optimization and energy performance requirements.

3. CPO vendor shall provide written commissioning test procedure specification prior to commissioning of the optimization system and provide the completed test report upon successful commissioning.

3.3 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide remote assistance in adjusting system to suit occupied conditions.

3.4 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to remotely train Owner's maintenance personnel to operate, and maintain Central Plant Optimization System provided per this Section.
   1. Coordinate with Division 23 09 23 Direct-Digital Control System for HVAC subcontractor to provide training in joint training sessions.
   2. Provide a minimum of 40 hours of total remote training for CPO system.

B. Provide quarterly performance reports as determined by the Owner that show the energy performance of the facility compared to minimum requirements listed in this Section. Provide explanations and recommended corrective action for any elements that do not meet the minimum energy performance criteria listed in this Section.

3.5 SERVICE AND TECHNICAL SUPPORT

A. Provide a toll-free number to call for live service support and the ability to dispatch service personnel on a 24/7 basis from the nearest metropolitan area.

B. Provide technical phone support for optimization during regular business hours.

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